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Monitoring of gamma radiation in São José dos Campos and correlation of rain intensity in the local.

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ABSTRACT :*During 06/28/2017 to 10/16/2017, low energy gamma rays and rainfalls were monitored every minute in São José dos Campos. In this period, it was possible to see the dynamic process that occurs between the presence of low energy ionizing radiation (gamma rays 200 keV at 10 MeV) and the variation of rain intensity in (mm / min) in the same region. This positive correlation of (rain / radiation) is very noticeable in the tropical region of Brazil, which is certainly due to the presence of the disintegration of Uranium ^{238}U to Radium^{226}Ra and reaching Radon ^{222}Rn with emission of α particles and low energy gamma radiation. In sequence, rain interferes with the presence of the local exhalation of the radon gas causing the washing of this gas in the low atmosphere increasing the intensity of radiation measured in the site. This work shows the dynamics observed in this period of 2017 that there was a rainy and dryer climate at the place of measurements in campus of (ITA).*

KEYWORDS*Gamma rays, Ionizing Radiation, rainfall.*

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I. INTRODUCTION

At the (ground / air) interface of the Earth's surface, ionizing radiation is composed mainly of radon gas, soil telluric radiation and primary and secondary cosmic ray radiation. However, it is difficult to separate over time the intensity of the ionizing radiation emanating from each component as the energies overlap.Gamma ray spectra have relatively low wavelengths (λ), on the order of picometers, which increases their penetration power in the environment. Due to its high energy rate, this radiation has an ionizing effect, so it can cause damage to the cellular nucleus of living beings.

The telluric radiation is given by ^{238}U, ^{235}U, ^{40}K and ^{232}Th constant for each region[1]. Radon gas comes from the disintegration of ^{238}U from the Earth's crust to ^{226}Ra and ^{222}Rn reaching the isotopes ^{214}Pb, ^{214}Po and ^{214}Bi giving α and gamma radiation[2]. The primary cosmic radiation consists mainly of galactic and extragalactic protons and the very high energy of Sun that interacts with Earth's atmosphere producing the EAS (Extensive Air Showers). The efficiency of this interaction is highest when it occurs at altitudes between 15 and 17 km in the tropics that form secondary cosmic rays with muonic, mesonic and neutronic components that reach the surface of the Earth in the region. These radiations can cause health problems for crew and passengers in civil aviation. At that altitude beginning of the stratosphere is called Pfotzer maximum[3]. However, this component contributes less to the concentration of radiation on the Earth's surface. Another possible source of ionizing radiation in the Earth's lower atmosphere is produced by electrical (lightning) discharges between earth-clouds, clouds-earth and cloud-cloud. X-rays, gamma rays, neutrons and beta particles are all formed in the cone of lightning. Other sources of ionizing radiation are those produced in medical, dental and hospital clinics, but these radiations are mainly controlled in small areas.

II. METHODOLOGY

The fully portable equipment, the gamma-scintillator is surrounded by a thin layer of aluminum for its protection, the set (scintillator + associated electronics + data acquisition) only needs a PC with battery charged to measure the radiation for 5 continuous hours. However for series of long measurements it uses electrical network or photovoltaic energy. The scintillator and associated electronics were calibrated in terms of energy and counting intensity per minute at the experimental teaching physics laboratory of ITA using radioactive sources and a spectral analyzer of counts versus energy in the range of 0.2 to 10 MeV (Million Volt Electron) . The rainfall intensity in (mm) was measured with a scraper type rain gauge and a data logger for data acquisition developed in ITA according to international recommendations.

Data acquisition in terms of ionizing radiation and rainfall intensity were performed using a time interval of 1 minute between each measurement. This detail contributes to verify possible correlations between the variation of the rain intensity and the local ionizing radiation. The set of devices was installed in a room 25 meters high from the ground. The rain detector is placed on the ceiling outside the room with electrical and electronic interface cables connected to computers and data logger inside the room. The tower is closed, with controlled ambient temperature of 20 degrees Celsius. The same tower was used to observe lightning in the region since the years 2000 until now.

Fig.1. Location of measures GPS [$23^0 12´;45^0 52´$](ACA Tower).

III. RESULTS

The measurements were performed between June 28, 2017 to October 16, 2017 in the same location shown in Figure 1, in the 25 meter high (ACA tower). The interval between each measurement was chosen in 1 minute. Thus it was possible to verify times with rains and the dynamics of the ionizing radiation in the region in this interval. Figure 2 shows throughout this period, 2 intense rains seen through the peaks of measured gamma radiation.

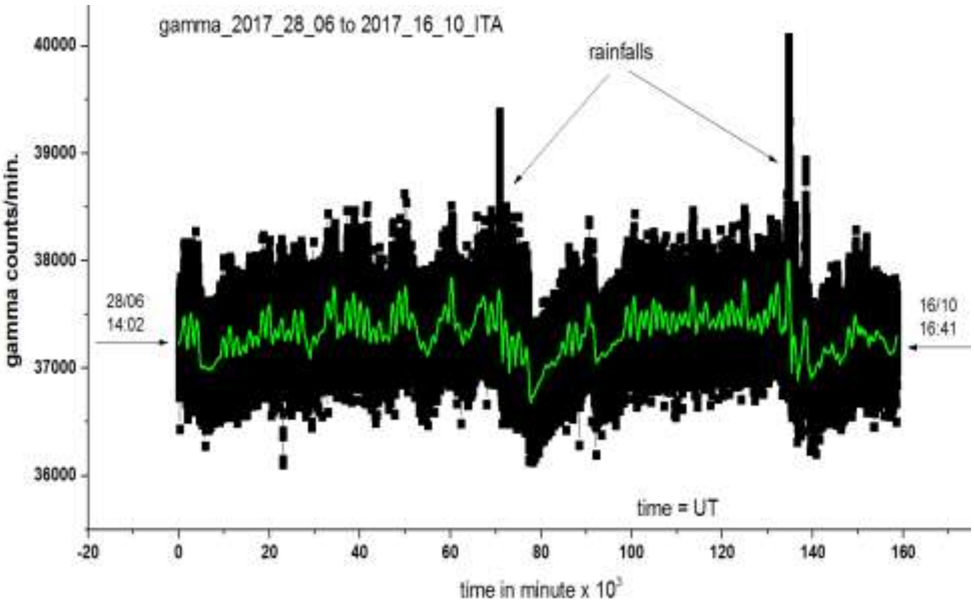

Fig. 2. Measurements of gamma rays – range of 06/28/2017 to 10/16/2017. Green line indicate 1 day smoothed curve.

The following figure 3 shows a "zoom" obtained in the range of 66000 minutes to 78000 minutes. The graph related is obtained through the measurements made by the rain gauge referring to the period from 12/08 to 21/08, in which there is a strong rainfall on August 16. Other weaker rains on the later days were also measured and observed on the gamma radiation plot. The arrival of heavy rain caused a significant increase in the gamma ray count due to the increase of the radon gas into the soil. The comparison of the two graphs shows that the peaks of gamma radiation that were generated exactly at the same time that there were rains in the region.

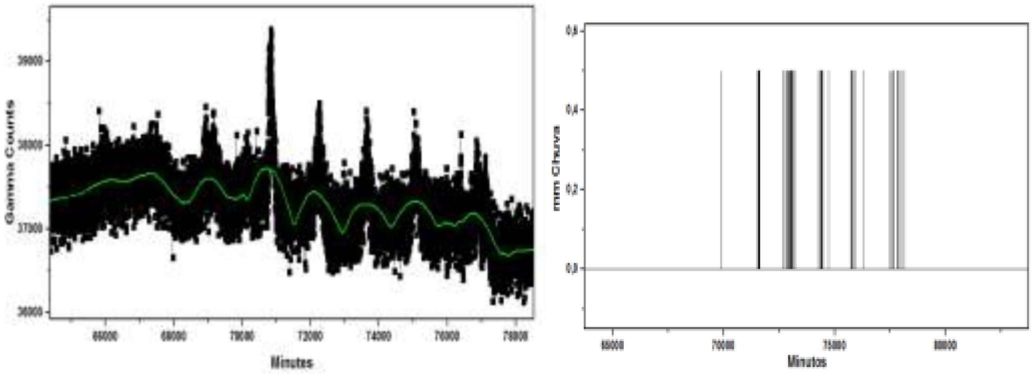

Fig. 3.Monitoring of gamma radiation and rainfall in the period from 08/08 to 23/08 of 2017mudar

During the period from 100000 minutes to 1400000 minutes referring to 30/09 to 03/10 in the figure below, a long dry period is observed except for four small moderate rains identified with the gamma radiation graph oscillating of days and nights. Note that the radiation is more intense during the day. This occurs with the origin of the greatest exhalation of the radon gas coming from the ground. Exactly on day 29/09 there was a strong rainfall observed in the highest peak of gamma radiation shown in figure 4, and another two moderate rains in the later days.

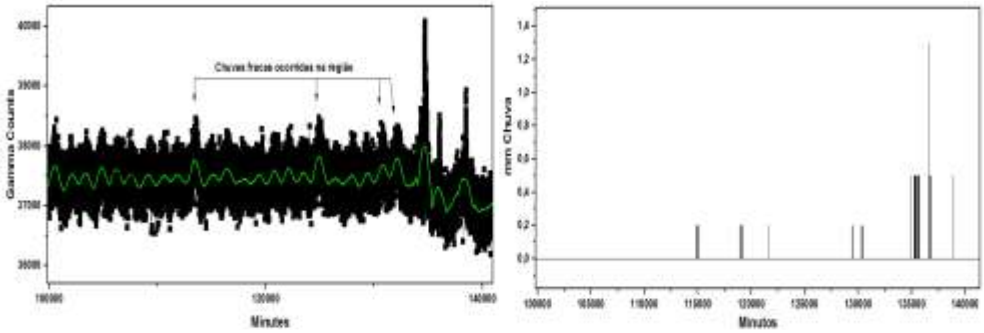

Fig. 4. Drought period in the range of 100000 minutes to 13000 minutes followed by heavy rain. The green line corresponding 1 day smoothed curve.mudar

After the rainfall of 135,000 minutes, the gamma radiation begins to stabilize, as well as the standard regime in the region of São José dos Campos, as shown in figure 5.

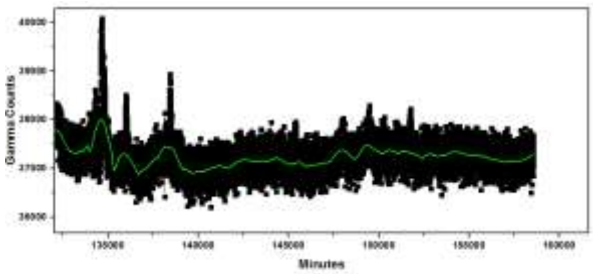

Fig. 5.Measuring period after rains occurring around 135000 minutes.

Analyzing the dynamics of gamma radiation measured from minute to minute as a function of time at a fixed location, one can also observe the dynamics of the variation of rainfall occurring in the same place. Figure 6 shows the rainfall spectrum in function of time measured in the same period and in the same place always with a one-minute interval between each measurement performed.

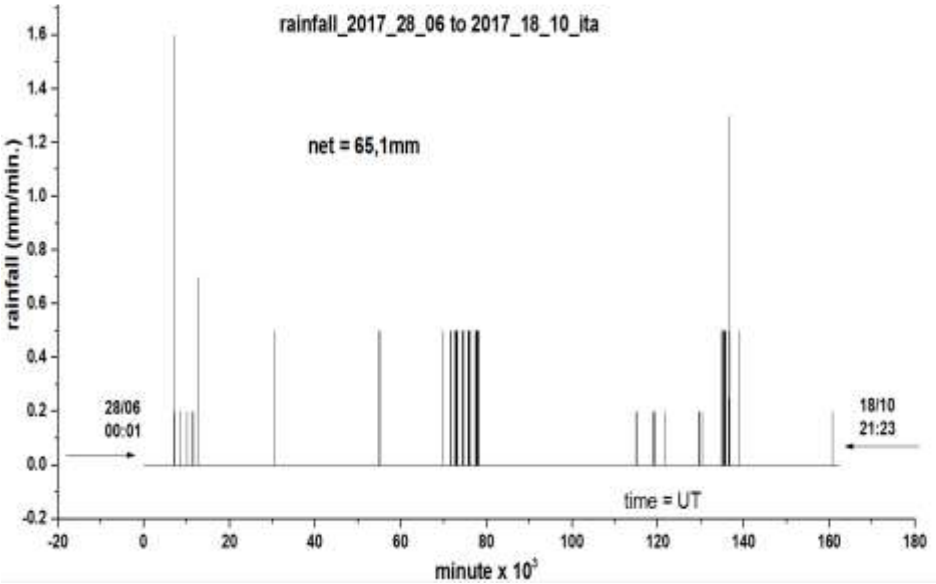

Fig. 6.Spectrum in time of rainfalls occurred every minute between 28/06 to 18/10 in 2017.

IV. CONCLUSION

In this work paper, using a simple gamma ray detector in the energy range 0.2 to 10.0 MeV, it was possible to correlate measurements of this radiation with rainfalls measurements of the region, performed between June 28 and October 16, 2017. This positive (rainfall / radiation) correlation is very noticeable in the tropical region of Brazil. That phenomenoncertainly is due to the presence of the decay of Uranium ^{238}U in Radium ^{226}Ra and decaying in the Radon ^{222}Rn with emissions of alpha particles and low energy gamma radiation. Once the calibration between the intensity of rain and the intensity of gamma radiation in the place could be possible to measure rain intensity by monitoring the gamma radiation in the region.

REFERENCES

[1]. Bui, Van, N. A., Martin, I. M., and.Júnior, A. T. 1988. "Measurements of Natural Radioactivity at Different Atmospheric Depths." Geophysics Magazine 28: 262-266.

[2]. Fujinami, N. 2009. "Study of Radon Progeny Distribution and Radiation Dose Rate in the Atmosphere." Japan Journal Health Physics 44 (1): 88-94.

[3]. Grieder, P.K.F. 2010. Extensive Air Showers, Book Springer: Verlag Berlin Heidelberg.

[4]. Malyshevsky, V. S.and.Fomin, G. V.; Electromagnetic Radiation in the Atmosphere Generated by Excess Negative Charge in a Nuclear-Electromagnetic Cascade, NASA Astrophysics Data System (ADS), 2017,https://www.science.gov/topicpages/e/electromagnetic+cascade+shower.html acessado em 06/07/2017.

[5]. Jayanthi U B, Gusev A A, Neri J A C F, Villela T, Júnior O P, Pugacheva G I, Talavera K C, Martin I M (2005). Ground Gamma Radiation Associated with Lightning and Rain Precipitation, In 29th I, Cosmic Ray Conference (1): 177-810.

[6]. Ravisankar, R., Vanasundari, K., Chandrasekaran, A., Rajalakshmi, A., Suganya, M.,Vijayagopal, P.&Meenakshisundaram, V. (2012). Measurement of natural radioactivity in building materials of Namakkal, Tamil Nadu, India using gamma-ray spectrometry. Applied Radiation and Isotopes, 70 (4): 699-704.

[7]. Boardman B J (2015). Aware Electronic Corp. Accessed in 2017. www.aw-el.com

[8]. Matheus Carlos Silva1, Douglas Carlos Vilela1, Victor G. Migoto1, Marcelo P. Gomes1, Inácio M. Martin1 and Silvério J. Germano1, Ionizing radiation measurements using low cost instruments for teaching in college or high-school in Brazil submitted to Physics Education, may 2017 see http://iopscience.iop.org/journal/0031-9120.

[9]. https://www.ventusky.com/; Acessado em 07/11/2017.

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